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in their sections, and unable to cultivate it on their culture media, and consequently, have very generally reached the conclusion that it does not exist. Granted the existence of such an organism, and we have a ready explanation for the growth of the cancer cell in defiance of the physiological needs of the organism. The hitherto inexplicable occasional change in the nature of the cell-growth of tumors, *e. g.*, from epithelial to carcinomatous and from carcinomatous to sarcomatous also finds its explanation in the presence of a sensitive microorganism growing usually in the kind of cell originally infected but capable under certain circumstances of invading other types of cells.

ERWIN F. SMITH

U. S. DEPARTMENT OF AGRICULTURE

[The illustrations accompanying this address will be reproduced at an early date in a bulletin to be published by the U. S. Department of Agriculture.]

#### THE ROYAL ENGINEERING COLLEGE AT CHARLOTTENBURG-BERLIN

DIE Königlische technische Hochschule zu Berlin<sup>1</sup> is the leading school for higher learning in technical subjects in the German Empire. It is not an imperial institution; but was founded and is supported by the state of Prussia. It is under the immediate control of the Prussian University of Public Instruction.

This school covers, in general, the same ground as the Massachusetts Institute of Technology, the Troy Polytechnic, the Stevens Institute and the schools or colleges of engineering in our own state universities, including, like that of Illinois,

<sup>1</sup> This term has been translated into English in many different ways: the Royal Technical College; the Technical University; etc. I prefer the one I have placed at the head of this article.

for instance, a department of architecture.<sup>2</sup>

The constitutional statute as revised in 1882 declares it to be "the purpose of the Technische Hochschule to furnish a suitable higher training for technical careers in the public service of the state and the municipalities as well as for private practise in the industrial life of the nation; and further (and this is very important) to cultivate the sciences and the arts which underlie the field of technical instruction."<sup>3</sup>

The school is divided into six departments: Architecture; Civil Engineering; Mechanical and Electrical Engineering; Marine Engineering and Construction; Chemistry and Metallurgy; and General Science, including Mathematics and the Natural Sciences.

The requirements for admission have in common for all departments the certificate of graduation from a gymnasium, real-gymnasium, or higher realschule; *i. e.*, the ordinary preparatory classical or scientific college of the German empire.<sup>4</sup>

A year's practical work in a shop or factory is furthermore required of those who wish to take the technical degree in mechanical or electrical engineering and in a ship yard for those who wish to take marine engineering. A shorter time of practical work suffices for the candidates

<sup>2</sup> The engineering school at the University of Illinois was organized along similar lines to those of the school at Charlottenburg. Its first dean was Dr. Nathan C. Ricker, who was a student in Germany in his early years.

<sup>3</sup> The German never loses sight of the fact that the promotion of our scientific knowledge by original investigation and research is fundamental to all successful organization of higher education.

<sup>4</sup> The normal age for completing this preparatory course is 18 years. The average age, however, and the age of the majority of the graduates is nearer 19; although many finish the course at 17 and a few at 16.

in chemistry and metallurgy. This practical experience takes the place of the school shop work in our American institutions. Half of this work may be made up in vacations during the course so that the whole period of study after the preparatory school is finished is lengthened only six months by this provision.

The course of the engineering school is four years in length and leads up to a final examination, the successful completion of which entitles one to the degree of Certificated Engineer (*Diplom-Ingenieur*).

The degree of Doctor of Engineering (*Doktor-Ingenieur*) may be obtained without further attendance on systematic courses of instruction upon the presentation of a satisfactory scientific thesis "which demonstrates the capacity of the candidate for independent scientific work in the technical field," and the passing of an oral examination.

As it ordinarily requires several months' hard work to prepare such a thesis, the candidate rarely obtains his doctor's degree within a shorter time than one year after his degree of certificated engineer is obtained; though the law does not require any specified time to elapse between the taking of the two degrees.

The thesis which is required in connection with the examination for certificated engineer will not be accepted as a doctor's thesis.

With this brief statement of fact it may be interesting to compare the course and requirements of the Royal College at Charlottenburg with our own institutions.

The normal German boy should enter the gymnasium, or *realschule*, at nine years of age and complete the course by the time he is eighteen. If he then puts in a full year in a shop he will be nineteen when he enters the Engineering College with his shop work completed. By the time he has com-

pleted his four-year engineering course and obtained the degree of certificated engineer he will be twenty-three. By spending one year more he can take his doctor's degree at twenty-four.

As seen from the above account, he can shorten this time materially. First, by completing his preparatory course at 17 instead of 18, which is easy for the capable and industrious boy; second, by putting half of his practical year into the long vacations, thus saving six months; and, third, by completing his thesis for the doctor's degree in six months which is also thoroughly feasible. A student who pursues this course could obtain his doctor's degree at twenty-two instead of twenty-four.

On the other hand, the average boy takes until he is nineteen to complete his preparatory course; wastes six months, and often a year, in "enjoying his academic freedom" and takes more than the schedule time for the doctor's degree, arriving at that point in his twenty-fifth or twenty-sixth year.

Now, take the American boy who is looking forward to the doctor's degree in engineering at, say the University of Illinois. Suppose he graduates at a good Chicago high school. He will be eighteen years old if he has pursued the normal course, *i. e.*, enters the primary school at six years of age; completes the eight grades and enters the high school at fourteen, taking the regular time of four years for the full course for graduation.

He must now take four years for the ordinary course, leading to the bachelor's degree in engineering. By this time he is twenty-two. He must then take three years' graduate work for the degree of doctor in engineering, making him twenty-five years of age—*i. e.*, one year older than the German who takes the normal time.

The American boy can abridge his course one full year by completing his preparatory course at seventeen, as he can easily do if he has brains and industry. He may cut the college course by another six months if he is specially well prepared, able and industrious and may thus take his doctor's degree at twenty-three and one half.

On the other hand, the average boy slips a cog somewhere like his German brother and loses time along the way. Our statistics show that the average age of the freshman entering the University of Illinois is a little over nineteen instead of eighteen as it should be; or seventeen as it might well be; or even sixteen, as it sometimes is. Many students lose again in college and must return for a part or the whole of a fifth year before getting their first degree. Such students, however, would rarely be considered as candidates for the doctor's degree, nor would they care themselves to attempt it.

It will thus be seen that the courses in the two countries run along somewhat parallel lines so far as the formal requirements are concerned.

The German *realschule*, or *gymnasium*, is, on the whole, a more thorough and effective center of training than the American high school. The teachers are better educated and the discipline is more severe. The German boy *must work* or he is thrown out of the school. The American boy is permitted to dawdle along and fool away a good portion of his time without running any serious risk of dismissal or even of being required to take the year's work over again.

In the best American high schools with properly educated teachers the American boy has a *chance* of acquiring as good a training as his German brother, or would have such a chance, if the lazy idlers in his

class could be put in a division by themselves. Under the actual circumstances, he must use one year in college, and some high authorities would say two years, in order to get as far along in real mental training and effective knowledge as the German boy when he leaves the preparatory school.

The German engineering school gives little attention to the so-called general subjects in its curriculum. These are taken care of in the preparatory school. No languages or history appear, among the required or elective subjects. Certain general subjects which have a practical value for the engineer, like commercial law, patent law, finance, political economy, etc., are listed among the possible courses to be chosen, while opportunity is also offered for courses in foreign languages—French, Russian, English, etc.

To put our American engineering schools on a par with the German as educational institutions, we must first of all improve the quality of our preparatory instruction. This will be done, not by lengthening the college course, or by merely requiring a bachelor's degree for admission; but by insisting that the student who wishes to take up engineering studies should have a thorough grounding in the elements of a liberal education, including the mother tongue, foreign languages, mathematics, history and the natural sciences. This can all be acquired by the time the student is eighteen or nineteen years of age without spending three or four years in college after leaving the high school. Perhaps a good compromise might be effected for a time by requiring one or two years of general study in an arts course as a preliminary requirement for admission to the technical courses. If mathematics and physics, chemistry and drawing, were prescribed for this college

period it might fairly enough be fixed at two years. In this way, a five years' course, after leaving the high school, could be worked out leading to a technical degree, which might then in one more year lead to a doctor's degree. The present situation is one of unstable equilibrium. Our ultimate hope lies in the development of the public high school into an effective tory instruction.

It is interesting to note how many men come up at Charlottenburg for their final examinations and the diploma and for the doctor's degree during the year. The attendance of matriculated, *i. e.*, regular students at the Hochschule during the year ending June 30, 1911, was 2,060 (average for the two semesters). Of these, 336 passed successfully the examinations for the degree of Certificated Engineer—roughly one in six of the total number. Forty-two took the doctor's degree in engineering, *i. e.*, one in fifty.

During the week I spent in a careful study of the Hochschule and its workings I was greatly impressed by the emphasis laid on training the men to independent methods of work, and by the manifest desire to turn out, not highly trained artisans or mechanics, but independent thinkers within the field of technical pursuits—men who because of their mental development will be able to lead in whatever field they may enter. EDMUND J. JAMES

CHARLOTTENBURG-BERLIN, GERMANY,  
January 1, 1912

#### WILLIAM EMERSON DAMON

THE death of William Emerson Damon on December 1, in Windsor, Vermont, at the age of seventy-three, recalls to his friends memories of his early days, when his enthusiastic devotion to natural history studies in general, and more especially to ichthyology and pisciculture, caused him to become the leading spirit in the establishment of New

York's first aquarium. This first venture was a department of Barnum's old Ann Street museum. It was due to Mr. Damon's persuasion that the irrepressible showman was induced to undertake this enterprise; however, unexpected difficulties were encountered in securing specimens from the South Atlantic, but few of the fish being alive when they reached New York. Finally a special craft was chartered and placed under Mr. Damon's immediate control.

This was in 1863, during our Civil War, and some very interesting details regarding this expedition have been furnished by Professor Albert S. Bickmore. Barnum, who had just acquired the "Aquarial Gardens" in Boston, wrote to Professor Agassiz, of Harvard, that if the latter had an assistant whom he would like to send along to collect specimens for the Museum of Comparative Zoology in Cambridge, all facilities would be accorded to him. This offer was accepted by Agassiz, who selected Professor Bickmore as his representative. The little fishing-smack chartered for the trip was given the high-sounding name *Pacific*. Its equipment, however, was of the simplest, not even a chronometer being on board, so that when, after coasting along until Cape Hatteras was reached, the course was laid due east, and the ship passed out of sight of land, there was no means of determining its exact position. Fortunately, half-way toward Bermuda, an East-Indiaman was met, and the adventurous seamen were able to learn their precise latitude and longitude.

On the arrival of the little craft in Bermuda, Professor Bickmore writes:

As we came near Port Hamilton, the principal harbor, a number of native boats put off to board us, for what purpose we were at a loss to imagine, until one more skilfully managed than the others came alongside, and its black crew offered to aid us as agents. "What for?" we asked; to which came the rejoinder: "Why, when we saw how you could sail in a strong breeze, we felt sure you were a 'blockade-runner' loaded with tobacco."

When the entirely peaceful intentions of the newcomers were made plain, the authorities facilitated their operations and some 600